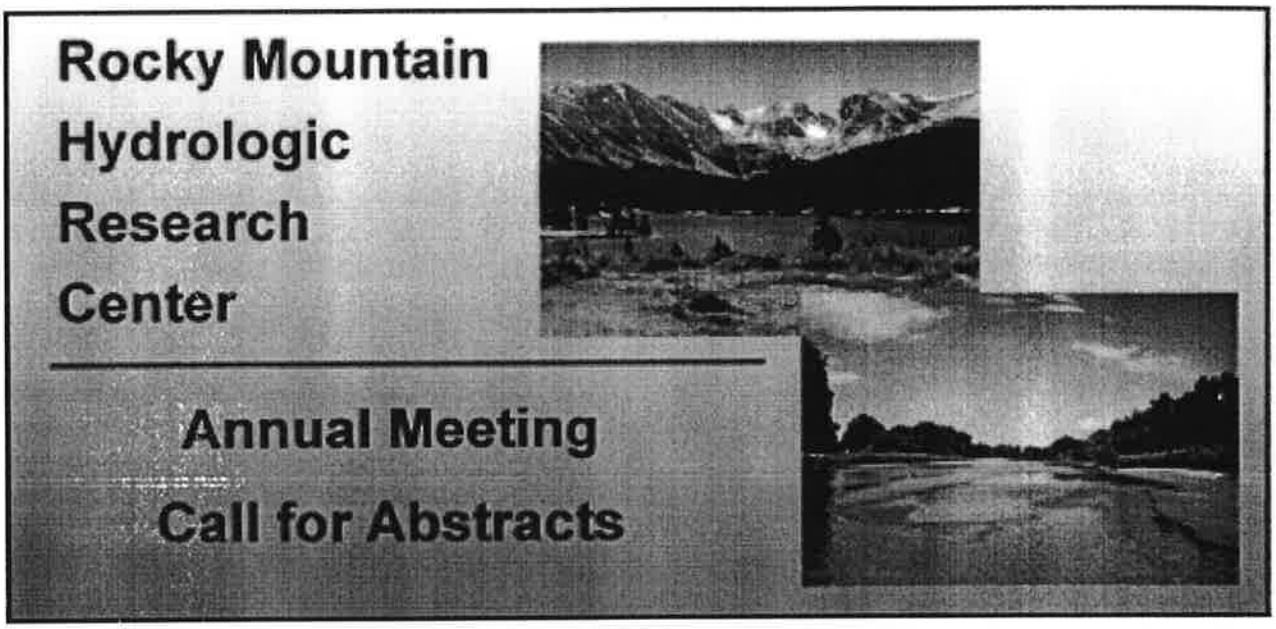
Meeting Program and Abstracts



57th Annual Meeting

University of Colorado

Boulder, CO

September 27, 2002

Meeting Schedule

8:30 Welcome

8:40 Jospeh Alfieri and Peter Blanken, University of Colorado-Boulder, The Relationship Between NDVI and Soil Moisture Over Sparse Grassland Canopies

9:00 Heide Baden and Peter Blanken, University of Colorado-Boulder, Plant Transpiration from Selected Species in High Creek Fen, Park County, Colorado

9:20 Martyn Clark, Lauren Hay, Subhrendu Gangopadhyay, John Schaake, Jeffrey Whittaker, Improving Operational Streamflow Forecasting Capabilities

9:40 Laura Landrum, Jill Baron and Christina Tague, Colorado State University and NREL, Effects of projected climate change on ecosystem and hydrologic properties in the Big Thompson Watershed, Colorado: Model results from the Regional HydroEcological Simulation System (RHESSys)

10-10:20 Break

10:20 Eileen Gardner, William Lewis, and Diane McKnight, University of Colorado-Boulder, Effects of Atmospheric Nitrogen Deposition on the Seasonal Dynamics of Phytoplankton in an Alpine Lake, Colorado, U.S.A.

10:40 Greg Cronin and Paul Ellis, University of Colorado-Denver, The Influence of Ultraviolet Radiation and Nutrient Enrichment on the Benthic Community of a Subalpine Reach of the St. Vrain River, Rocky Mountain Hydrologic Research Center, Colorado.

11:00 Sujay Kaushal and William Lewis, University of Colorado-Boulder, Fate and Transport of Organic Nitrogen in Aquatic Ecosystems

11:20 Nolan Doesken and Jon Thomas, Colorado Climate Center and Colorado State University, The Drought of 2002

11:40 Connie Woodhouse, Jeffrey Lukas, and Robert Webb, NOAA Paleoclimatology Program and INSTAAR, University of Colorado-Boulder, Extended Hydroclimatic Records for Colorado Watersheds

12:00-1:15 Break

1:20 Kristin Bunte and Steven R. Abt, Colorado State University, Measurement of Coarse Gravel and Cobble Transport Using Portable Bedload Traps: Effect of Sampler Size and Sampling Time

1:40 Robert Milhous and James Terrell, U.S. Geological Survey, Sediment as Habitat for the Worms Associated with Whirling Disease

2:00 John Moody and Brian Ragan, Simulation of Wildfire Effects on the Erodibility of Sediment

2:20 Brian P. Bledsoe, Colorado State University, Re-Examining the Meandering-Braiding Threshold

2:40 John Pitlick and Erich Mueller, University of Colorado-Boulder, Adjustments of Channel Width and Bed Material Properties to Downstream Changes in Discharge and Sediment Load

3:00 Board Meeting

The Relationship Between NDVI and Soil Moisture Over Sparse Grassland Canopies

J G Alfieri & P D Blanken
University of Colorado at Boulder
Department of Geography
Guggenheim 201C
Campus Box 260
Boulder, Colorado 80309

While droughts, floods, and other severe weather events cause billions of dollars of property damage and lost productivity annually, the ability of the meteorological community to anticipate and mitigate these phenomena is very limited. Therefore, in order to improve the predictive capabilities of weather and climatological models, the International H2O Project 2002 (IHOP) was undertaken in the Southern Great Plains of the United States during the summer of 2002. Utilizing a variety of measurement and analysis techniques, IHOP sought to better characterize the movement of water vapor through the atmosphere. As a part of that large-scale project, this study sought to investigate the evapotranspiration (ET) over a sparse grassland site in the Panhandle of Oklahoma with the objective of partitioning the vegetative and the soil component of ET. To accomplish this goal, the relationships between ET and both the Normalized Difference Vegetation Index (NDVI), as a proxy for biomass, and soil moisture content (SMC) were determined. Analysis of these relationships suggested that ET was a function solely of SMC at sparse grassland site. It was concluded that NDVI may not be indicative of biomass for regions characterized by a sparse canopy. Since this type of sparsely vegetated biome is common globally, it is further suggested that developing alternate methods of characterizing biomass may be both prudent and beneficial for improving atmospheric models.

Plant Transpiration from Selected Species in High Creek Fen, Park County, Colorado

Heide Baden and Peter Blanken

Department of Geography, Box 260 University of Colorado-Boulder

(contact: Heide.Baden@Colorado.EDU)

Wetlands represent significant agents in the global water cycle, but their latent heat flux and contribution to atmospheric moisture is often underestimated. Loss of water through plant transpiration from selected species in High Creek Fen, located at 2850 m a.s.l. in Park County, Colorado was measured with a porometer (LICOR LI1600) over one growing season. Values were compared between different species in comparable locations as well as between same species in locations that differed in average soil moisture; optimal stomatal conductance was further related to parameters such as quantum flux and leaf temperature. Results showed intra- and inter-specific variation between willows, birch and sedge, and indicated that a possible change in species composition could occur if the amount of ground water supply to the fen was significantly altered. Further, results suggested that considering species composition is mandatory when modeling the latent heat flux from ecosystems such as High Creek Fen.

IMPROVING OPERATIONAL STREAMFLOW FORECASTING CAPABILITIES

Martyn P. Clark (Center for Science and Technology Policy Research, 1333 Grandview Ave, Campus Box 488, University of Colorado at Boulder, Boulder CO 80309-0488; Tel: 303-735-3624; Fax: 303-735-1576; e-mail: clark@vorticity.Colorado.EDU).

Lauren E. Hay (Water Resources Division, United States Geological Survey, Denver Federal Center MS412, Lakewood CO 80225-0046; Tel: 303-236-7279; Fax: 303-236-5034; e-mail: lhay@usgs.gov).

Subhrendu Gangopadhyay (Center for Science and Technology Policy Research, 1333 Grandview Ave, Campus Box 488, University of Colorado at Boulder, Boulder CO 80309-0488; Tel: 303-735-3624; Fax: 303-735-1576; e-mail: Subhrendu.Gangopadhyay@Colorado.EDU).

John C. Schaake (NOAA National Weather Service, Office of Hydrology, Silver Spring, MD 20910; Tel: 301-713-1660; Fax: 301-713-0963; e-mail: John.Schaake@noaa.gov).

Jeffrey S. Whittaker (NOAA-CIRES Climate Diagnostics Center, 325 Broadway R/CDC1, Boulder CO 80303; Tel: 303-497-6313; Fax: 303-497-6449; e-mail: jsw@cdc.noaa.gov).

A new collaborative effort between NOAA, the University of Colorado, the United States Geological Survey, and the National Weather Service's Office of Hydrologic Development is currently developing experimental procedures to facilitate the use of Medium-Range Numerical Weather Prediction model output in operational hydrological forecasting applications. Our experimental hydrologic prediction system involves five main elements: a) generate an archive of atmospheric forecasts from the same model that is used operationally; b) develop statistical relationships between this archived forecast output and precipitation and temperature at local scales in individual river basins, and apply these relationships to the operational forecast model output to produce unbiased, improved forecasts of precipitation and temperature; c) assimilate real-time station observations of precipitation and temperature and, in mountainous basins, satellite estimates of snow extent into hydrologic models to estimate basin initial conditions; d) run hydrologic models in ensemble mode to estimate forecast uncertainty; and e) apply a hydrologic post-processor to forecasts of runoff to remove systematic biases. Results show that there is considerable value in downscaled MRF output in snowmelt-dominated river basins, where daily variations in runoff are influenced more by temperature than precipitation. Improvements in local-scale forecasts of precipitation variability are necessary to provide valuable forecasts of streamflow in rainfall-dominated river basins.

Effects of projected climate change on ecosystem and hydrologic properties in the Big Thompson Watershed, Colorado: Model results from the Regional HydroEcological Simulation System (RHESSys)

Landrum, Laura L., NREL, Colorado State University, Fort Collins, CO, 80523, llandrum@nrel.colostate.edu; Baron, Jill S., USGS, NREL, Colorado State University, Fort Collins, CO, 80523, jill@nrel.colostate.edu ; and Tague, Christina, Department of Geography, San Diego State University, San Diego, CA, 92182, ctague@mail.sdsu.edu.

We ran RHESSys, a GIS-based, hydro-ecological modeling framework designed to simulate carbon, water and nutrient fluxes with observed and Global Climate Model (GCM) scenarios for the 42,000 sq. km Big Thompson Watershed in Colorado. RHESSys uses observed meteorology and GIS landscape partitioning layers as input. Three process models are coupled within RHESSys to simulate meteorology over topographically varying terrain, ecosystem canopy processes, and watershed hydrological processes.13% of the Big Thompson catchment is alpine rock and talus, 18% is alpine tundra, 66% is forested, and 3% is mountain meadow. RHESSys simulations using climate warming scenarios for the Big Thompson watershed show strong changes in the timing of snowmelt, but they suggest more complex changes in productivity, evapotranspiration and annual discharge.

EFFECTS OF ATMOSPHERIC NITROGEN DEPOSITION ON THE SEASONAL DYNAMICS OF PHYTOPLANKTON IN AN ALPINE LAKE, COLORADO, U.S.A.

Gardner, E.M., W.M. Lewis, Jr., and D.M. McKnight

Enrichment of aquatic ecosystems with nitrogen may alter seasonal changes in the productivity and composition of phytoplankton communities. The effect of nitrogen deposition on phytoplankton dynamics is being investigated in an alpine lake located near the Niwot Ridge LTER site in northern Colorado. Primary production was quantified and samples for community composition analysis were collected during the summer months of 2000, 2001, and 2002. During the summer of 2002, nutrient enrichment experiments were performed in isolated, 20-liter mesocosms in order to 1) investigate nutrient limitation on algal productivity within the lake and 2) to determine the potential effects of continued increases in nitrogen on community composition. The chemical environment of the water column was also characterized during the same time periods in order to interpret changes in algal communities. Water samples were analyzed for major ions, pH, acid-neutralizing capacity (ANC), organic and inorganic fractions of nitrogen and phosphorous, and specific conductance. Chlorophyll *a* concentrations were analyzed for samples in both the water column and the enrichment experiment. Within the water column, nitrate concentrations were highest following snowmelt, and decreased throughout the summer. ANC and pH were lowest following snowmelt and increased throughout the summer. The rapid increase in nitrogen during snowmelt may be caused by atmospheric deposition of nitrogen. Primary production peaked following snowmelt and again in late summer. The community composition of phytoplankton in each sample is now being investigated. The preliminary results of the enrichment experiments indicate that the study lake is phosphorous-limited throughout the summer, and thus a potentially nitrogen-saturated system.

Fate and Transport of Organic Nitrogen in Aquatic Ecosystems

Sujay S. Kaushal and William M. Lewis, Jr.

Very little is known regarding the fate of organic nitrogen exported from terrestrial environments. Organic nitrogen may be an ecologically significant component of the nitrogen cycle in aquatic ecosystems, particularly those with low availability of inorganic nitrogen. We investigated the chemical and biological lability of dissolved organic nitrogen (DON) transported in two small streams draining watersheds, which receive low rates of atmospheric nitrogen pollution (ca. 3 kg/ha/y). As inorganic nitrogen declined in the streams, concentrations of DON increased linearly and became the most abundant form of nitrogen. Chromatographic separation of organic matter revealed that DON was comprised mostly of biologically reactive non-humic compounds whereas dissolved organic carbon (DOC) was primarily derived from more refractory humic substances. Organic carbon and nitrogen differed in their seasonal patterns of chemical fractionation and metabolism suggesting a decoupling of carbon and nitrogen cycling in these low nitrogen streams. Laboratory experiments indicated that the metabolism of DON remained high across a range of substrate quality and was influenced by the availability of inorganic N and P. Consumption of DON in incubations decreased exponentially as the availability of inorganic N increased in stream water over a seasonal cycle. Throughout the growing season, biologically available DON constituted a substantial proportion (up to 50-60%) of the total dissolved nitrogen exported from the watersheds. Our work suggests that metabolism of organic nitrogen may provide an important source of nitrogen to aquatic ecosystems which have been minimally affected by human perturbation.

The Influence of Ultraviolet Radiation and Nutrient Enrichment on the Benthic Community of a Subalpine Reach of the St. Vrain River, Rocky Mountain Hydrologic Research Center, Colorado

Greg Cronin and Paul Ellis

The amounts of ultraviolet radiation (UVR) and nutrients reaching ecosystems on Earth's surface have increased in recent decades due to the actions of humans. To assess the direct and interactive effects of these anthropogenic stressors on stream benthic communities, a 2 x 2 factorial experiment with 2 levels of UVR (ambient and <5% ambient) and 2 levels of nutrient availability (ambient and augmented) was conducted in situ at a subalpine reach of the St. Vrain River in Colorado. The St. Vrain is little-impacted by humans, with most of its drainage coming from Rocky Mountain National Park. Though forested, it received full sunlight for about 5 hours a day during this 9 week long experiment. Periphyton samples were collected weekly from ceramic tiles, but have not been processed yet. Macroinvertebrates were collected at the end of the experiment using 40x20x20 cm colonization traps filled with stream substrates. UVR had no statistically significant effects (P=.075) on macroinvertebrate assemblages, though the direction of the trend was that UVR was detrimental to the Family Biotic Index (FBI). In contrast, nutrient augmentation had a small, but significant, beneficial effect on the FBI. An overall FBI of 1.93, based upon 6367 specimens, indicated excellent habitat quality, as would be expected at this pristine site. Despite some significant effects on macroinvertebrates, we detected no significant effects of our treatments on the breakdown of aspen or spruce leaves.

Extended Hydroclimatic Records for Colorado Watersheds

Connie A. Woodhouse[1], Jeffrey J. Lukas[2], and Robert S. Webb[3]

[1]NOAA Paleoclimatology Program, National Geophysical Data Center, Boulder, CO
[2]INSTAAR, University of Colorado, Boulder, CO
[3]Climate Diagnostics Center, OAR, NOAA, Boulder CO

Tree rings can be used to reconstruct records of hydrologic variables for the past 400-600 years or longer. Under a new NOAA project entitled *Extended Hydroclimatic Records for the Upper Colorado River Basin,* we are developing new tree-ring based hydroclimatic reconstructions for the Front Range and western Colorado and improving their utility to water resource managers through a collaborative process now in its initial phase. The project objectives are to develop a set of hydroclimatic reconstructions that are key to water resource managers, and to use feedback from potential users to guide the development and presentation of reconstruction data products and subsequent research. Reconstructions will be used to evaluate the characteristics of extreme flow/snowpack events over the past four to six centuries in comparison with 20th century events, to investigate linkages between drought in the Colorado watersheds and other parts of the western U.S., and to determine relationships between atmospheric circulation and regional drought. In addition, the hydroclimatic reconstructions will be used to evaluate climate model estimates of the range of hydroclimate variability and reoccurrence of extreme events. As reconstructions are developed, they will be archived in an online database.

More than 30 new tree-ring chronologies from across Colorado have been developed as the basis for the new hydrologic reconstructions, with another 10 collections under development, and more sites yet to be collected. These chronologies are from moisture-sensitive pinyon pine, ponderosa pine, and Douglas-fir trees ranging from 300 to over 800 years of age. Preliminary reconstructions of April 1 snow water equivalent (SWE), annual streamflow, and the standard precipitation index (SPI) demonstrate the high quality of reconstructions possible for this region. With these initial reconstructions, we have begun to address the concerns of water managers, specifically in assessing the unusualness of the current drought, and in more general terms, in investigating the character of regional drought in a long-tem context. Preliminary analyses suggest that the current drought year is unusually severe, but not unprecedented in the past 300-500 years. When viewed as a three-year drought event, there is evidence for similarly severe and even more severe sequences of drought years in past centuries.

SEDIMENT AS HABITAT FOR THE WORMS ASSOCIATED WITH WHIRLING DISEASE.

Robert T. Milhous and James W. Terrell

Fort Collins Science Center
U.S. Geological Survey
Fort Collins, Colorado

ABSTRACT

Sediment is habitat for the tubifex worms that are an intermediate host of the organisms causing whirling disease in trout. High infestations of the tubifex worms lead to significant levels of whirling disease but there appears to be a threshold in the level of tubifex worm infestation below which the levels of whirling disease appear to be insignificant. The size of the fine sediment deposited on the substrate surface of a stream may determine why some streams have high tubifex worm infestations and others do not. Sieve analysis and preliminary worm counts of sediment samples from Willow Creek in Grand County, Colorado indicate if fines less than 1.5 mm are absent from the substrate surface there will be low levels of tubifex infestation in the stream. A hydraulic model has been used to calculate the streamflows needed to remove the fine sediment from Willow Creek. In addition to sediment size, there may also be some substrate specific weight impacts on the infestation of the tubifex worms that needs to be investigated further.

Measurement of coarse gravel and cobble transport using portable bedload traps: effect of sampler size and sampling time

KRISTIN BUNTE and STEVEN R. ABT

Engineering Research Center, Colorado State University, Fort Collins, CO 80523, USA

email: kbunte@engr.colostate.edu; phone: (970) 491-3980

Abstract A bedload trap was developed for sampling gravel and cobble bedload and tested in four mountain gravel/cobble-bed rivers during wadable flows. The portable bedload traps have an opening 0.3 m wide and 0.2 m high with an almost meter long trailing net designed to capture particles sizes from fine gravel to cobble and a large volume of bedload material. Traps are positioned on a fixed ground plate to minimize disturbance of the streambed during sampling and can be emptied without removing the traps from the streambed. This design allows for long sampling durations of up to one hour which are necessary for sampling particle sizes that are just becoming mobile and only move infrequently. Samples collected with the bedload traps have well-defined relationships between bedload transport rates and discharge and steep power function rating curves with exponents of 8-16. Compared to a Helley-Smith sampler with a 7.6 by 7.6 cm opening, transport collected with the bedload traps are smaller during low flows and larger during high flows. Collected bedload coarsens more pronouncedly with flow when measured with the bedload traps compared to Helley-Smith samples. These differences in sampled bedload transport rates and size-distributions have implications for subsequent computations such as critical discharge, annual load, and effective discharge.

Simulation of Wildfire Effects on the Erodibility of Sediment

John A. Moody, U.S. Geological Survey, 3215 Marine St. Suite E-127, Boulder, Colorado, 80303
Brian W. Ragan, Geosciences Department, Boise State University, Boise, Idaho, 83725

Wildfires change soil properties and hence the hydrologic and erosional response of burned watersheds. One important property that may be altered is the erodibility (effective cohesion) of the soil. Soil on an unburned mountainous hillslope consists of mixed grain sizes varying from gravel- to clay-sized particles. The clay-sized particles, various types of organic material (for example: polysaccharides, aromatic compounds, fungi, rootlets, and hyphae), and various silicates and oxides can form different types of bonds that provide soil cohesion. This experiment investigated the temperature effects on the erodibility of samples of forest soil.

Erodibility is defined here as the critical shear stress required for significant sediment motion and was measured in a small water flume. Because the soil samples consisted of mixed grain sizes and organic material at different stages of cohesion, the criteria for significant motion had two definitions. They were: 1) the continuous motion of coarse-sized particles (1-2 mm diameter) occurring at some location on the surface of mostly fine particles (0.1-0.5 mm diameter) or 2) continuous erosion of large aggregates of sediment and organic material. Samples were placed in porcelain boats (surface area 15 mm x 80 mm), subjected to different temperatures (150°C to 550°C) in a muffle furnace, and then placed in a tilting flume with water depths ranging from 3 to 15 mm. The flume was tilted until significant motion was observed and the critical shear stress was estimated as the product of the water depth and water surface slope. Initial estimates of the critical shear stresses for forest soils not subjected to substantial heating (<40°C) averaged 2.3 N/m^2. The critical shear stress reached a maximum of at least 2.8 N/m^2 at 200°C and then decreased rapidly to 0.60 N/m^2 at 250°C. From 250°C to 550°C the critical shear stress was nearly constant decreasing to 0.27 N/m^2. Thus, an increase in temperature at first decreased the erodibility by probably drying and strengthening bonds. An increase in temperature greater than 250°C appears to have significantly increased the erodibility by probably destroying those bonds.

Re-Examining the Meandering – Braiding Threshold

Brian P. Bledsoe
Department of Civil Engineering
Colorado State University

An extensive data set describing sand and gravel bed streams and rivers was analyzed using a logistic regression approach to examine specific stream power relative to bed material size across meandering, braided and incising channel forms. Although incising and braiding sand bed streams exhibit similarly high levels of specific stream power relative to stable meandering streams, incision apparently initiates at levels of specific stream power that are less than those found in fully braided channels. Theoretical thresholds of channel stability developed by Chang using the extremal hypothesis of minimum stream power correspond quite well to the logistic models developed for sand bed channels. However, these theoretical thresholds do not exclusively represent a transition to braiding in sand bed channels as suggested. Instead, Chang's regions correspond to rapidly increasing probabilities of vertical or lateral adjustment, depending on the relative resistance of bed and bank materials. In general, the logistic regression analyses depict a more realistic assessment of the uncertainty associated with previously identified thresholds of channel form and instability.